

US-PAT-NO: 6388674

DOCUMENT-IDENTIFIER: US 6388674 B1

TITLE: Gamut mapping method and
apparatus

DATE-ISSUED: May 14, 2002

US-CL-CURRENT: 345/590, 345/589 , 345/591 ,
345/600 , 358/519 , 358/520
, 382/166 , 382/167

APPL-NO: 09/ 315978

DATE FILED: May 21, 1999

COUNTRY	FOREIGN-APPL-PRIORITY-DATA:
APPL-DATE	APPL-NO
JP	10-148131
1998	May 28,

----- KWIC -----

Brief Summary Text - BSTX (16):

It is generally said that the gamut mapping should preferably be done in a two-dimensional plane of the lightness L* and chroma C* in the CIE/L*C*h space while the hue h is being maintained constant. More particularly, the gamut mapping methods include a chroma compression in which only the chroma C* is

compressed while the lightness L^* and hue h are being kept constant as shown in FIG. 4, a lightness compression in which the lightness L^* is compressed in a direction of $(L^*, a^*, b) = (50, 0, 0)$ while the hue h is being kept constant as shown in FIG. 5, and other methods. Further, for a gamut mapping by three-dimensional compression of the lightness, chroma and hue h as well, it has been proposed to weight the three color difference items (lightness, chroma and hue differences) (referred to as "coefficient of compressibility" hereinunder) and then map the lightness, chroma and hue in the direction of a minimum color difference.

Brief Summary Text - BSTX (17):

In the gamut mapping in which the lightness or chroma is compressed with the hue kept constant, such as the lightness or chroma compression, an emphasis has to be put on the compression in the direction of lightness or chroma, which causes the following problems:

Brief Summary Text - BSTX (19):

To prevent the above as much as possible, the compressions in the direction of lightness L^* and C^* should be done at reduced ratios, respectively, in a gamut mapping in which the hue h is somewhat changed. To solve this problem, the Inventor of the present invention has disclosed, in the Japanese Published Unexamined Patent Application No. 08-238760, a gamut mapping method in which

coefficients of compressibility are assigned to the lightness, chroma and hue differences, respectively, by weighting. This gamut mapping method permits to compress the lightness L^* , chroma C^* and hue h in a good balance. However, all data outside the gamut are mapped over the gamut with a result that colors compressed in a same direction are all mapped in a same color, so that they lose the gradation.

Brief Summary Text - BSTX (22):

The above object can be attained by providing a color mapping method of changing, when an output color gamut is different from an input color gamut, the input color gamut to the output color gamut by correcting the color using a predetermined function for a difference in the lightness-directional dynamic range and correcting the color by a combination of a three-dimensional compression of lightness, chroma and hue and a two-dimensional shrinkage or expansion of the lightness and chroma.

Brief Summary Text - BSTX (24):

The above object can also be attained by providing a color mapping apparatus comprising a color mapping means for changing, when an output color gamut is different from an input color gamut, a color in the input color gamut to one in the output color gamut by using a color mapping table created by correcting the color using a predetermined function for a difference in the

lightness-directional dynamic range, and then correcting the color by a combination of a three-dimensional compression of lightness, chroma and hue and a two-dimensional shrinkage or expansion of the lightness and chroma.

Brief Summary Text - BSTX (26):

The Invention of the present invention has proposed a two-dimensional compression of lightness and chroma (as in the Japanese Published Unexamined Patent Application No. 09-098298) and a three-dimensional compression of lightness, chroma and hue (as in the Japanese Published Unexamined Patent Application No. 08-238760). In the two-dimensional gamut compression, a consideration is given to the gradation in a high chroma area. The three-dimensional gamut compression permits to prevent the contrast of a picture from being lowered and keeps the picture vivid for a third dimension.

Detailed Description Text - DETX (17):

In the gamut mapping at step S4, first a color correction is done using a function such as an exponential function to correct a lightness-directional difference. Then, a color correction is done by a combination of a three-dimensional compression of lightness, chroma and hue and a two-dimensional compression of lightness and hue. The one-, two- and three-dimensional compressions will be described in the following:

Detailed Description Text - DETX (25):

Two-dimensional Compression: Gamut Mapping for
Lightness and Chroma

Detailed Description Text - DETX (45):

The algorithm employed in the gamut mapping method according to the present invention is such that the three terms (lightness, chroma and hue differences) in the ordinary color difference formula are weighted (the weighting factors are referred to as "coefficient of compressibility" hereinunder) for gamut compression in a direction in which each color difference is minimized. Namely, it is an algorithm for such a color that when the following formula (4) is used to estimate the color differences, the difference ΔE is minimized.

Detailed Description Text - DETX (63):

The gamut mapping method having been described in the foregoing transforms a color of a picture to a color signal for each of the weighted three terms in the color difference formula (lightness difference ΔL^* , chroma difference ΔC^*_{ab} and hue difference ΔH^*_{ab}) to be minimum, thereby permitting to fully keep the characteristics such as contrast, third dimension and vividness of a picture. Also, the method divides a picture into two areas of lightness and chroma with the hue kept constant and compresses each area

optimally, thereby permitting to maintain the gradation in an area having a large chroma. Furthermore, the method corrects a lightness-directional deviation between the input and output devices, thereby permitting to prevent a black compression or the like from taking place and keep the gradation of a picture at a low lightness. Thus, the color gamut of the output device can be used to the full extent.

Detailed Description Text - DETX (65):

As having been described in the foregoing, the present invention provides a gamut mapping method of changing, when an output color gamut is different from an input color gamut, the input color gamut to the output color gamut by correcting the color with a predetermined function for a difference in the lightness-directional dynamic range, and correcting the color by a combination of a three-dimensional compression of lightness, chroma and hue and a two-dimensional shrinkage or expansion of the lightness and chroma. Therefore, even when a color signal outside the output color gamut smaller than the input color gamut is supplied, the gamut mapping method according to the present invention can transform the input color signal to the output color gamut while fully keeping the characteristics such as contrast, third dimension and vividness of a picture. Therefore, the present invention permits to provide an output device such as a printer, and so forth, capable of a natural color

reproduction at different types of devices in a picture input/output system such as DTP, and so forth.

Claims Text - CLTX (17):

a color mapping means for changing, when an output color gamut is different from an input color gamut, a color in the input color gamut to one in the output color gamut by using a color mapping table, said color mapping table created by using a predetermined function for a difference in the lightness-directional dynamic range, and then combining a three-dimensional compression of lightness, chroma and hue and a two-dimensional shrinkage or expansion of the lightness and chroma, wherein said means includes means for dividing the input gamut by four with a first straight line passing through a minimum value point L^*_{min} of the lightness L^* in the output gamut and a second straight line passing through a maximum value point L^*_{max} of the lightness L^* in the output gamut, these first and second straight lines intersecting each other at a point (C^*_{th}, L^*_{th}) of the lightness value L^*_{th} having a maximum chroma value C^*_{max} of the output gamut in a two-dimensional plane of the lightness L^* and chroma C^* with the hue kept constant, thereby defining an area A above the first straight line and below the second straight line, an input area B other than the area A and corresponding to the output color gamut, an input area C other than an area corresponding to the output color gamut, and an

area D other than the output and input color gamuts.

US-PAT-NO: 5317426

DOCUMENT-IDENTIFIER: US 5317426 A

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TITLE: Color estimation method for
expanding a color image for
reproduction in a different
color gamut

DATE-ISSUED: May 31, 1994

US-CL-CURRENT: 358/515, 358/501 , 358/518 ,
358/519 , 358/520

APPL-NO: 07/ 796251

DATE FILED: November 22, 1991

COUNTRY	FOREIGN-APPL-PRIORITY-DATA:	
APPL-DATE	APPL-NO	
JP	2-321687	November
26, 1990		
JP	2-321688	November
26, 1990		

----- KWIC -----

Abstract Text - ABTX (1):

The invention provides a method of transforming a color image data of a first media (color hardcopy) so as to be reproduced by a second media (color CRT), the color reproducing capability of which is

larger than that of the first media. The chroma of color image data "T" is compared with a threshold value which is "a" ($a < 1.0$) times of the maximum chroma of the first color gamut of the first media at the lightness "LT" and the hue ".theta.T" of the color image data "T". The chroma "rT" is enlarge in accordance with the comparison result without changing the hue ".theta.T".

Brief Summary Text - BSTX (10):

For example, in the conventional method for moving chroma to a high chroma side with the hue fixed after enlargement operation to match the maximum and minimum of lightness, there are problems imposed such that the movement distance is determined according to the external form of the color gamut, and the hue is always fixed and the chroma is unbalanced during movement.

Brief Summary Text - BSTX (21):

u^* and v^* or a^* and b^* among the values of the colorimetric system obtained for an optional combination of the input color component image information are not corrected when that chroma is smaller than a value which is "a" ($a < 1.0$) times of the maximum chroma value of the input side color gamut on the straight line passing the lightness and chroma at the hue. When the chroma is larger than the abovementioned value which is "a" times of the maximum chroma value of the input side color gamut on the above straight line, u^* and v^* or a^* and b^*

are converted so that, while the hue is fixed, the chroma is converted according to the ratio of the difference between the maximum chroma value on the above straight line of the input side color gamut and the abovementioned value which is "a" times of the maximum chroma on the above straight line of the input side color gamut to the difference between the maximum chroma value on the above straight line of the output side color gamut and the abovementioned value which is "a" times of the maximum chroma of the input side color gamut.

Brief Summary Text - BSTX (27):

A combination of output color component image information can be obtained in correspondence with the enlarged and mapped colorimetric system value. Therefore, the obtained color reproduction by the output color component image information covers the entire output color reproduction gamut naturally and provides a sufficient lightness or chroma range.

Brief Summary Text - BSTX (29):

According to another invention to attain the first object of the invention, u^* and v^* or a^* and b^* among the values of the colorimetric system obtained for an optional combination of the input color component image information are not corrected when the chroma is smaller than a value which is "a" ($a < 1.0$) times of the maximum chroma value at the hue and lightness of the input side color

gamut. When the chroma is larger than the above mentioned value, u^* and v^* or a^* and b^* are converted so that to the area enclosed by the inner color gamut surface which comprises a value which is "a" times of the maximum chroma value at each hue and lightness of the input side color gamut and the outer surface of the input side color gamut which comprises the maximum chroma value at each hue and lightness of the input side color gamut; the entire area enclosed with the above mentioned inner surface of the input side color gamut and the outer surface of the output side color gamut which comprises the maximum chroma value at each hue and lightness of the output side color gamut corresponds continuously.

Brief Summary Text - BSTX (33):

By doing this, the color reproduction gamut on the input side is included in the color reproduction gamut on the output side by natural conversion with the entire chroma balance kept, the color reproduction obtained by the output color component image information provides satisfactory lightness and chroma, and the chroma is well balanced as a whole.

Detailed Description Text - DETX (81):

Values wherein only values of combinations for the outer surface of the color gamut are converted to lightness L^* , chroma r , and hue θ . are used. There are 8 surfaces which constitute the outer

surface of the color gamut,
where the values of Y' , M' , and C' or R , G , and B
are all 0 or maximum. The
lattice point containing the hue θ and
lightness L^* is searched for, and
the maximum chroma value is obtained from the
chroma values at 4 peripheral
points by weight average.

Detailed Description Text - DETX (200):

By doing this, the color reproduction gamut of
printed matter is expanded to
the color reproduction gamut of the color CRT by a
natural conversion result,
and the color reproduction obtained by a
combination of R , G , and B provides
satisfactory and natural lightness and chroma. In
this example, for example,
in a high or low lightness area, the slope of the
straight line is positive or
negative and the increase amount of chroma is
suppressed when the chroma is
increased and mapped, and hence excessive increase
in only colors caused by
enlarging and mapping, which causes color
reproduction to be unnatural, can be
suppressed.

Detailed Description Text - DETX (209):

When the chroma of the input side color gamut is
enlarged and mapped, the
hue is moved so that the peak of each color of the
input side color gamut moves
toward the peak of the corresponding color of the
output side color gamut.
Therefore, the color reproduction gamut on the
input side is expanded to the
color reproduction gamut on the output side by

natural conversion with the entire chroma balance kept, the color reproduction obtained by the output color component image information provides satisfactory lightness and chroma, and the chroma is well balanced as a whole.

Claims Text - CLTX (23):

comparing a chroma "rT" of the color image data "T" of the first media with a threshold value which is "a" ($a < 1.0$) times the maximum chroma "rlmax" of the first color gamut at a lightness "LT" and a hue ".theta.T" of the color image data "T"; and

Claims Text - CLTX (27):

assuming a first region enclosed between an inner gamut surface comprising a value which is "a" ($a < 1.0$) times the maximum chroma of each of hue and lightness of the first color gamut and the outer surface of the first color gamut including the maximum chroma of each of the hue and the lightness of the first color gamut, and a second region enclosed between said inner gamut surface and the outer surface of the second color gamut which comprises the maximum chroma value of each of hue and lightness of the second color gamut, and

US-PAT-NO: 6301383

DOCUMENT-IDENTIFIER: US 6301383 B1

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TITLE: Image processing apparatus
and method

DATE-ISSUED: October 9, 2001

US-CL-CURRENT: 382/162, 358/518 , 358/520 ,
382/167

APPL-NO: 08/ 925678

DATE FILED: September 9, 1997

COUNTRY	FOREIGN-APPL-PRIORITY-DATA:
APPL-DATE	APPL-NO
JP	8-238760
September 10, 1996	

----- KWIC -----

Brief Summary Text - BSTX (14):

The gamut mapping is performed in a color space which does not depend on a device, and is normally performed, particularly in a CIE/L*C*h color space (color space formed by converting an L*a*b* color space to polar coordinates) corresponding to human visual characteristics. In the CIE/L*C*h, L*, C* and h

represent lightness, chroma and hue, respectively.

Brief Summary Text - BSTX (15):

Conventionally, when gamut mapping is performed, hue is fixed in a CIE/L*C*h color space, and lightness and chroma are compressed on a two-dimensional plane comprising lightness and chroma.

Brief Summary Text - BSTX (17):

According to the above-described method in which gamut mapping is performed while fixing hue, lightness or chroma is greatly compressed, problems occur because compression of lightness decreases contrast and a stereoscopic effect of an image, and a deterioration in chroma decreases brightness to form an image from which an impression cannot be made.

US-PAT-NO: 5991511

DOCUMENT-IDENTIFIER: US 5991511 A

TITLE: Appearance-based technique
for rendering colors on an
output device

DATE-ISSUED: November 23, 1999

US-CL-CURRENT: 358/1.9, 358/1.1 , 358/518 ,
358/520 , 358/523 , 382/162
, 382/167

APPL-NO: 08/ 871487

DATE FILED: June 9, 1997

PARENT-CASE:

This application is a continuation of U.S.
application Ser. No.
08/595,404, filed Feb. 5, 1996, now U.S. Pat.
No. 5,650,942, which claims
priority from U.S. Provisional Application No.
60/011,064, filed Feb. 2,
1996, the entire disclosures of which are hereby
incorporated by reference.

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Drawing Description Text - DRTX (13):

FIG. 12 is a V-T-D plot showing gamut mapping
for an out-of-chroma and

out-of-lightness situation;

Detailed Description Text - DETX (47):

As mentioned above, the gamut mapping or gamut compression problem arises when the target output device is incapable of rendering every color that is specified in the input image. The problem is similar to that of sweeping dirt under a rug. The lump in the rug (the mapping error) needs to be hidden in some dark corner out of sight, while presenting to the casual visitor the appearance of a properly cleaned house. As will be seen in connection with the discussion below, the invention seeks to preserve lightness (where possible) and hue, while reducing chroma if necessary to achieve excellent appearance.

Detailed Description Text - DETX (48):

FIG. 10 is a V-T-D plot showing gamut mapping for an out-of-lightness situation, i.e., a situation where the color to be rendered has a lightness (V value) that is too large for the printer to render at the pixel's chroma (r value). Put another way, the pixel designated 130 is above the umbrella surface (the projection in the plane being line 60), but within the maximum chroma limit (defined by maximum chroma line 65). This is shown schematically as the pixel defining a vector 135 that intersects line 60 at a point 140. This manifests itself in the pixel's specified V.sub.pix being greater than V.sub.top for the pixel's r and .theta.

coordinates, i.e., V.sub.top for point 140.

Detailed Description Text - DETX (52):

FIG. 11 is a V-T-D plot showing gamut mapping for an out-of-chroma situation, i.e., a situation where the color to be rendered for a pixel 150 has a chroma (r value) that is too large for the printer to render at the pixel's lightness (V value). Put another way, the pixel is outside the maximum chroma limit, but still below the umbrella surface (as extended downwardly past the border point).

Detailed Description Text - DETX (54):

FIG. 12 is a V-T-D plot showing gamut mapping for a pixel 160 presenting an out-of-chroma and out-of-lightness situation. This situation is handled in the same manner as the out-of-lightness but within chroma situation discussed above. Pixel 160 is mapped to a point on the umbrella surface that has the same lightness. Again, the darkness is 0.

system is smaller than that of the input system, the gamut of the input system is divided into four portions in a two-dimensional plane of lightness and chroma, under a constant color hue, using two straight line segments, and gamut compression is done by varying the compressing direction from one area to another, for converting the color in the gamut of the input system into the color in the gamut of the output system.

Detailed Description Text - DETX (7):

That is, the color gamut compression processor 32 divides the gamut GMin of the input system for the color picture data of the CIE/L* C* into four portions, in the two-dimensional plane of the lightness L* and chroma C*, under the constant color phase h, using two straight line segments, as shown in FIG. 8.

Detailed Description Text - DETX (51):

The visual sense test was conducted using two sorts of CG images, that is a first image CG1 containing large amounts of yellow and green and a second image CG2 containing large amounts of blue and magenta. As the techniques for gamut compression, the conventional methods, that is the chroma compression (A), lightness compression (B) and the minimum color difference method (C), and the technique shown in FIG. 10 wherein $K=0$ (D), $K=0.75$ (E) and $K=1$ (F), were used. In a dark room not affected by extraneous light, a monitor and a light box were

placed in a 90. position centered about 33 panelists of which 19 were male and 14 were female. Two images of different gamut compression techniques, presented on the light box, and an image in the monitor, were presented for comparison to 33 panelists, who were then asked to judge which of the two images were more alike the image on the monitor for all combinations (6.times.5/2=15 combinations). For the images presented in the light box, an output image of an ink jet printer (A3+, 300 DPI, continuous system) and an output image of a sublimation type printer (A4, 163DPI) were used.

Detailed Description Text - DETX (54):

With the gamut compression method of the present invention, if the gamut of the output system is smaller than that of the input system, the gamut of the input system is divided into four portions in a two-dimensional plane of lightness and chroma, under a constant color hue, using two straight line segments, and gamut compression is done by varying the compressing direction for each area, for converting the color in the gamut of the input system into the color in the gamut of the output system, so that gamut compression can be done for realization of a more natural-looking image.

Detailed Description Text - DETX (56):

With the gamut compression method according to the present invention, in

which, in a two-dimensional plane of lightness L^* and chroma C^* of color picture data in the CIE/ $L^* C^* h$ color space, under a constant color phase h , the color of the input system is divided into four areas by a first straight line segment traversing the minimum value $L^*_{\text{sub.-- min}}$ of lightness L^* of the gamut of the output system and a second straight line segment traversing the maximum value $L^*_{\text{sub.-- max}}$ of lightness L^* of the gamut of the output system and intersecting the first straight line segment at a point $(C^*_{\text{sub.-- th}}, L^*_{\text{sub.-- th}})$ on a lightness value $L^*_{\text{sub.-- th}}$ having the maximum chroma value of $C^*_{\text{sub.-- max}}$ in the gamut of the output system, wherein the color of the first area above said first straight line segment and below the second straight line segment is left as is, the color of the second area lying above the first and second straight line segments is compressed in the direction of a point $(0, L^*_{\text{sub.-- min}})$, the color of the third area lying below the first and second straight line segments is compressed in the direction of a point $(0, L^*_{\text{sub.-- max}})$ and the color of the fourth area lying below the first straight line segment and above the second straight line segment is compressed in the direction of a point $(C^*_{\text{sub.-- th}}, L^*_{\text{sub.-- th}})$, compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to

a certain extent in the high chroma area, that is in the fourth area.

Detailed Description Text - DETX (57):

Moreover, with the gamut compression method according to the present invention, in which the point $(C^*.sub.-- th, L^*.sub.-- th)$ is moved by a parameter K given by $C^*.sub.-- th = C^*.sub.-- max.times.K$, where $0 < K < 1$, the gradients of the first and second line segments can be varied for setting the compressing direction from one area to another. In addition, the lowering in the chroma direction may be minimized by increasing the parameter K, while the variation in the lightness direction may be reduced and gradation in the high chroma area may be improved by decreasing the value of K.

Detailed Description Text - DETX (62):

where the maximum values of the gamut of the input system and the output system on a straight line segment traversing two points of $(L^*.sub.-- th, C^*.sub.-- th, h.sub.-- in)$, $(L^*.sub.-- in, C^*.sub.-- in, h.sub.-- in)$ are $(L^*.sub.-- m, C^* m, h.sub.-- in)$ and $(L^*.sub.-- p, C^*.sub.-- p, h.sub.-- in)$. The result is that compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to a certain extent in the

high chroma area, that is in the fourth area. Moreover, there is no discontinuity in the threshold area produced by area division. Thus, for a color DPT system, gamut compression can be done in the CIE/L* C* h color space as the common color space while color reproducibility is maintained.

Detailed Description Text - DETX (77):

where the maximum values of the gamut of the output system for an area outside the gamut of the output system on a straight line segment traversing two points ($L^*.sub.-- th$, $C^*.sub.-- th$, $h.sub.-- in$), ($L^*.sub.-- in$, $C^* in$, $h.sub.-- in$) are ($L^*.sub.-- p$, $C^*.sub.-- p$, $h.sub.-- in$). The result is that compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to a certain extent in the high chroma area, that is in the fourth area. Moreover, there is no discontinuity in the threshold area produced by area division. Thus, for a color DPT system, gamut compression can be done in the CIE/L* C* h color space as the common color space while color reproducibility is maintained.

Detailed Description Text - DETX (78):

A gamut compression apparatus according to the present invention has area discrimination means for discriminating to which

one of four areas obtained when dividing the gamut of an input system in a two-dimensional plane of lightness and chroma under a constant color phase, using two straight line segments, belongs an input color picture, and gamut compression means for carrying out gamut compression of converting the color outside the gamut of an output system into the color inside the gamut of the output system as the compressing direction is varied from area to area based on area discrimination by said area discrimination means. The result is that the colors in the gamut of the input system can be converted into those in the gamut of the output system, in case the gamut of the output system is smaller than that of the input system, by way of gamut compression, in such a manner as to produce a more natural-looking image.

Detailed Description Text - DETX (79):

With the gamut compression apparatus according to the present invention, the area discrimination means judges to which of the four areas of the gamut of the input system divided by a first straight line segment traversing the minimum value L^*_{min} of lightness L^* of the gamut of the output system and a second straight line segment traversing the maximum value L^*_{max} of lightness L^* of the gamut of the output system, intersecting the first straight line segment at a point $(C^*_{\text{th}}, L^*_{\text{th}})$ on a lightness value L^*_{th} having the maximum chroma value of

$C^*_{sub.--}$ max in the gamut of
 the output system, belongs color data of the CIE/ L^*
 $C^*_{sub.--}$ h color space in a
 two-dimensional plane of lightness L^* and chroma
 C^* , under a constant color
 phase h, wherein the gamut compression means
carries out gamut compression
 based on the results of discrimination by the area
 discriminating means so that
 the color of the first area above the first
 straight line segment and below the
 second straight line segment is left as is, the
 color of the second area lying
 above the first and second straight line segments
 is compressed in the
 direction of a point $(0, L^*_{sub.--} \text{ min})$, the color
 of the third area lying
 below the first and second straight line segments
 is compressed in the
 direction of a point $(0, L^*_{sub.--} \text{ max})$ and the
 color of the fourth area lying
 below the first straight line segment and above the
 second straight line
 segment is compressed in the direction of a point
 $(C^*_{sub.--} \text{ th}, L^*_{sub.--} \text{ th})$.
 The result is that compression may be achieved in
 such a manner that chroma
 will be maintained as far as possible in the high
lightness area, that is in
 the second area, and in the low lightness area,
 that is in the third area, and
 in such a manner that gradation will be maintained
 to a certain extent in the
 high chroma area, that is in the fourth area.

Detailed Description Text - DETX (85):

where the maximum values of the gamut of the
 input system and the output
 system on a straight line traversing two points of

$(L^*.sub.-- th, C^*.sub.-- th, h.sub.-- in)$, $(L^*.sub.-- in, C^*.sub.-- in, h.sub.-- in)$ are $(L^*.sub.-- m, C^*.sub.-- m, h.sub.-- in)$ and $(L^*.sub.-- p, C^*.sub.-- p, h.sub.-- in)$. The result is that compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to a certain extent in the high chroma area, that is in the fourth area. Moreover, there is no discontinuity in the threshold area produced by area division. Thus, for a color DPT system, gamut compression can be done in the CIE/ $L^* C^* h$ color space as the common color space while color reproducibility is maintained. With the gamut compression apparatus according to the present invention, the value of the color picture data prior to gamut compression is set to $(L^* in, C^*.sub.-- in, h.sub.-- in)$, and the value of the color picture data subsequent to gamut compression is set to $(L^*.sub.-- out, C^*.sub.-- out, h out)$, compression is done in the second area in a direction of a point $(L^*.sub.-- min, 0, h.sub.-- in)$ which will give

Detailed Description Text - DETX (99):

where the maximum values of the gamut of the output system for an area outside the gamut of the output system on a straight line segment traversing two points $(L^*.sub.-- th, C^*.sub.-- th, h.sub.-- in)$, $(L^*.sub.-- in, C^* in,$

$h_{sub.--in}$) are ($L^*_{sub.--p}$, $C^*_{sub.--p}$, $h_{sub.--in}$). The result is that compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to a certain extent in the high chroma area, that is in the fourth area. Moreover, there is no discontinuity in the threshold area produced by area division. Thus, for a color DPT system, gamut compression can be done in the CIE/ L^* C^* h color space as the common color space while color reproducibility is maintained.

Claims Text - CLTX (6):

3. The method for gamut compression as claimed in claim 1 wherein, in a two-dimensional plane of lightness L^* and chroma C^* of color picture data in the CIE/ L^* C^* h color space, under a constant color phase h , the color of the input system is divided into four areas by a first straight line segment traversing the minimum value $L^*_{sub.--min}$ of lightness L^* of the gamut of the output system and a second straight line segment traversing the maximum value $L^*_{sub.--max}$ of lightness L^* of the gamut of the output system, said first and second straight line segments intersecting each other at a point ($C^*_{sub.--th}$, $L^*_{sub.--th}$) on a lightness value $L^*_{sub.--th}$ having the maximum chroma value of $C^*_{sub.--max}$ in the gamut of the output system;

Claims Text - CLTX (46):

9. The apparatus for gamut compression as claimed in claim 8 wherein said area discrimination means judges to which of the four areas of the gamut of the input system divided by a first straight line segment traversing the minimum value $L^*.sub.-- min$ of lightness L^* of the gamut of the output system and a second straight line segment traversing the maximum value $L^*.sub.-- max$ of lightness L^* of the gamut of the output system belongs color picture data in the CIE/ L^*C^*h color space, said first and second straight line segments intersecting each other at a point ($C^*.sub.-- th$, $L^*.sub.-- th$) on a lightness value $L^*.sub.-- th$ having the maximum chroma value of $C^*.sub.-- max$ in the gamut of the output system, in a two-dimensional plane of lightness L^* and chroma C^* , under a constant color phase h ; and wherein

US-PAT-NO: 6437792

DOCUMENT-IDENTIFIER: US 6437792 B1

TITLE: IMAGE PROCESSING APPARATUS
AND METHOD, COLOR GAMUT
CONVERSION TABLE CREATING
APPARATUS AND METHOD, STORAGE
MEDIUM HAVING IMAGE
PROCESSING PROGRAM RECORDED THEREIN,
AND STORAGE MEDIUM HAVING
RECORDED THEREIN COLOR GAMUT
CONVERSION TABLE CREATING
PROGRAM

DATE-ISSUED: August 20, 2002

US-CL-CURRENT: 345/600, 345/590 , 345/601 ,
345/603

APPL-NO: 09/ 488617

DATE FILED: January 20, 2000

COUNTRY	FOREIGN-APPL-PRIORITY-DATA:
APPL-DATE	APPL-NO
JP	11-014515
22, 1999	January
JP	11-200838
1999	July 14,

----- KWIC -----

Brief Summary Text - BSTX (19):

In the two-dimensional color gamut reduction, two of lightness, chroma and hue are changed. Normally in this two-dimensional color gamut reduction, the chroma and lightness should preferably be reduced while the hue is kept constant. For the two-dimensional color gamut reduction, various techniques have been proposed. For example, E. G. Pariser proposed to reduce the chroma and lightness in the direction of $(L^*, a^*, b^*) = (50, 0, 0)$ with the hue kept constant as shown in FIG. 7 (in his "An Investigation of Color Gamut Reduction Techniques", IS&T Symp. Elec. Prepress Tech.--Color Printing, pp. 105-107. (1991)). Also, the Japanese Unexamined Patent Application Publication No. 9-98298 has disclosed a technique that a color gamut should be divided for each hue and each divided color gamut be mapped in an optimum color gamut reducing direction as shown in FIG. 8.

Detailed Description Text - DETX (114):

As in the foregoing, a color signal whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the monitor color gamut is m:n is mapped along the profile of the output device imaginary color gamut whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the printer color gamut is x:y. The above processing is effected all the to-be-reduced input image color signals. Thus, the linear or nonlinear reduction can be adopted to

effect a color gamut reduction using the three-dimensions, namely, lightness, chroma and hue.

US-PAT-NO: 5991511

DOCUMENT-IDENTIFIER: US 5991511 A

TITLE: Appearance-based technique
for rendering colors on an
output device

DATE-ISSUED: November 23, 1999

US-CL-CURRENT: 358/1.9, 358/1.1 , 358/518 ,
358/520 , 358/523 , 382/162
, 382/167

APPL-NO: 08/ 871487

DATE FILED: June 9, 1997

PARENT-CASE:

This application is a continuation of U.S.
application Ser. No.
08/595,404, filed Feb. 5, 1996, now U.S. Pat.
No. 5,650,942, which claims
priority from U.S. Provisional Application No.
60/011,064, filed Feb. 2,
1996, the entire disclosures of which are hereby
incorporated by reference.

----- KWIC -----

Drawing Description Text - DRTX (13):

FIG. 12 is a V-T-D plot showing gamut mapping
for an out-of-chroma and

out-of-lightness situation;

Detailed Description Text - DETX (47):

As mentioned above, the gamut mapping or gamut compression problem arises when the target output device is incapable of rendering every color that is specified in the input image. The problem is similar to that of sweeping dirt under a rug. The lump in the rug (the mapping error) needs to be hidden in some dark corner out of sight, while presenting to the casual visitor the appearance of a properly cleaned house. As will be seen in connection with the discussion below, the invention seeks to preserve lightness (where possible) and hue, while reducing chroma if necessary to achieve excellent appearance.

Detailed Description Text - DETX (48):

FIG. 10 is a V-T-D plot showing gamut mapping for an out-of-lightness situation, i.e., a situation where the color to be rendered has a lightness (V value) that is too large for the printer to render at the pixel's chroma (r value). Put another way, the pixel designated 130 is above the umbrella surface (the projection in the plane being line 60), but within the maximum chroma limit (defined by maximum chroma line 65). This is shown schematically as the pixel defining a vector 135 that intersects line 60 at a point 140. This manifests itself in the pixel's specified V.sub.pix being greater than V.sub.top for the pixel's r and .theta.

coordinates, i.e., V.sub.top for point 140.

Detailed Description Text - DETX (52):

FIG. 11 is a V-T-D plot showing gamut mapping for an out-of-chroma situation, i.e., a situation where the color to be rendered for a pixel 150 has a chroma (r value) that is too large for the printer to render at the pixel's lightness (V value). Put another way, the pixel is outside the maximum chroma limit, but still below the umbrella surface (as extended downwardly past the border point).

Detailed Description Text - DETX (54):

FIG. 12 is a V-T-D plot showing gamut mapping for a pixel 160 presenting an out-of-chroma and out-of-lightness situation. This situation is handled in the same manner as the out-of-lightness but within chroma situation discussed above. Pixel 160 is mapped to a point on the umbrella surface that has the same lightness. Again, the darkness is 0.